

CLAIMS

What is claimed is:

1. A mixed extractant solvent for extracting cesium and strontium, comprising:
calix[4]arene-bis-(tert-octylbenzo)-crown-6 ("BOBCalixC6"), 4',4',5'-di-(t-butylidicyclohexano)-18-crown-6 ("DtBu18C6"), and at least one modifier dissolved in a diluent.
2. The mixed extractant solvent of claim 1, wherein the BOBCalixC6 is present from approximately 0.0025M to approximately 0.025M.
3. The mixed extractant solvent of claim 1, wherein the DtBu18C6 is present from approximately 0.01M to approximately 0.5M.
4. The mixed extractant solvent of claim 1, wherein the DtBu18C6 is present from approximately 0.086 M to approximately 0.108 M.
5. The mixed extractant solvent of claim 1, wherein the at least one modifier is 1-(2,2,3,3-tetrafluoropropoxy)-3-(4-sec-butylphenoxy)-2-propanol ("Cs-7SB").
6. The mixed extractant solvent of claim 1, wherein the at least one modifier is present from approximately 0.2M to approximately 1.0M.
7. The mixed extractant solvent of claim 1, wherein the diluent is an isoparaffinic hydrocarbon.
8. The mixed extractant solvent of claim 1, wherein the mixed extractant solvent comprises approximately 0.15M DtBu18C6, approximately 0.007M BOBCalixC6, and approximately 0.75M Cs-7SB modifier dissolved in an isoparaffinic hydrocarbon.
9. The mixed extractant solvent of claim 1, further comprising trioctylamine, tri-n-butyl phosphate, or mixtures thereof.

10. An extraction system for extracting cesium and strontium, comprising:
an organic phase comprising a mixed extractant solvent having calix[4]arene-bis-(tert-octylbenzo)-crown-6 ("BOBCalixC6"), 4',4',(5')-di-(t-butylidicyclo-hexano)-18-crown-6 ("DtBu18C6"), and at least one modifier dissolved in a diluent; and
an aqueous phase comprising an acidic solution including cesium and strontium.
11. The extraction system of claim 10, wherein the BOBCalixC6 is present in the mixed extractant solvent from approximately 0.0025M to approximately 0.025M.
12. The extraction system of claim 10, wherein the DtBu18C6 is present in the mixed solvent extractant from approximately 0.01M to approximately 0.5M.
13. The extraction system of claim 10, wherein the DtBu18C6 is present in the mixed extractant solvent from approximately 0.086 M to approximately 0.108 M.
14. The extraction system of claim 10, wherein at least one modifier is 1-(2,2,3,3-tetrafluoropropoxy)-3-(4-sec-butylphenoxy)-2-propanol ("Cs-7SB").
15. The extraction system of claim 10, wherein at least one modifier is present in the mixed extractant solvent from approximately 0.2M to approximately 1.0M.
16. The extraction system of claim 10, wherein the diluent is an isoparaffinic hydrocarbon.
17. The extraction system of claim 10, wherein the mixed extractant solvent comprises approximately 0.15M DtBu18C6, approximately 0.007M BOBCalixC6, and approximately 0.75M Cs-7SB modifier dissolved in an isoparaffinic hydrocarbon.
18. The extraction system of claim 10, wherein the mixed extractant solvent further comprises trioctylamine, tri-n-butyl phosphate, or mixtures thereof.

19. The extraction system of claim 10, wherein the acidic solution comprises an aqueous solution having from approximately 0.5M to approximately 3M nitric acid.

20. The extraction system of claim 10, wherein the acidic solution comprises a dissolved spent nuclear fuel including cesium and strontium.

21. A method of separating cesium and strontium from an acidic solution, comprising:
providing an acidic solution comprising cesium and strontium;
contacting the acidic solution with a mixed extractant solvent comprising calix[4]arene-bis-(tert-octylbenzo)-crown-6 ("BOBCalixC6"), 4',4',(5')-di-(t-butyl)dicyclo-hexano)-18-crown-6 ("DtBu18C6"), and at least one modifier dissolved in a diluent; and
removing the cesium and strontium from the acidic solution.

22. The method of claim 21, wherein providing an acidic solution comprising cesium and strontium comprises providing the acidic solution comprising from approximately 0.5M to approximately 3M nitric acid.

23. The method of claim 21, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent comprising from approximately 0.0025M to approximately 0.025M BOBCalixC6.

24. The method of claim 21, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent comprising from approximately 0.01M to approximately 0.5M DtBu18C6.

25. The method of claim 21, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent comprising from approximately 0.086 M to approximately 0.108 M DtBu18C6.

26. The method of claim 21, wherein contacting the acidic solution with a mixed solvent

extractant comprises contacting the acidic solution with the mixed extractant solvent comprising at least one modifier that includes 1-(2,2,3,3-tetrafluoropropoxy)-3-(4-sec-butylphenoxy)-2-propanol ("Cs-7SB").

27. The method of claim 26, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent comprising from approximately 0.2M to approximately 1.0M Cs-7SB.

28. The method of claim 21, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent comprising a diluent that includes an isoparaffinic hydrocarbon.

29. The method of claim 21, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent comprising approximately 0.15M DtBu18C6, approximately 0.007M BOBCalixC6, and approximately 0.75M Cs-7SB modifier dissolved in an isoparaffinic hydrocarbon diluent.

30. The method of claim 21, wherein contacting the acidic solution with a mixed solvent extractant comprises contacting the acidic solution with the mixed extractant solvent that further comprises trioctylamine, tri-n-butyl phosphate, or mixtures thereof as the at least one modifier.

31. The method of claim 21, wherein contacting the acidic solution with a mixed extractant solvent comprises forming a first organic phase and a first aqueous phase.

32. The method of claim 21, wherein contacting the acidic solution with a mixed extractant solvent comprises extracting the cesium and strontium into a first organic phase.

33. The method of claim 21, wherein removing the cesium and strontium from the acidic solution comprises separating a first organic phase and a first aqueous phase.

34. The method of claim 21, wherein removing the cesium and strontium from the acidic solution comprises removing the cesium and strontium at a temperature ranging from approximately 1°C to approximately 40°C.

35. The method of claim 21, wherein removing the cesium and strontium from the acidic solution comprises removing the cesium and strontium at a temperature ranging from approximately 10°C to approximately 15°C.

36. The method of claim 21, further comprising recovering the mixed extractant solvent, the cesium, and the strontium.

37. The method of claim 36, wherein recovering the mixed extractant solvent, the cesium, and the strontium comprises contacting a first organic phase with a second aqueous phase.

38. The method of claim 37, wherein contacting a first organic phase with a second aqueous phase comprises extracting the cesium and strontium into the second aqueous phase.

39. The method of claim 37, wherein contacting a first organic phase with a second aqueous phase comprises contacting the first organic phase with the second aqueous phase at a temperature ranging from approximately 10°C to approximately 60°C.

40. The method of claim 37, wherein contacting a first organic phase with a second aqueous phase comprises contacting the first organic phase with the second aqueous phase at a temperature ranging from approximately 20°C to approximately 40°C.

41. The method of claim 37, wherein contacting a first organic phase with a second aqueous phase comprises contacting the first organic phase with an aqueous solution comprising from approximately 0.001M nitric acid to approximately 0.5M nitric acid.

42. The method of claim 36, wherein recovering the mixed extractant solvent, the cesium, and the strontium comprises separating a first organic phase and a second aqueous phase.

43. A method of extracting strontium, comprising:
contacting an acidic solution comprising strontium with a solvent comprising 4',4',(5')-di-(t-butyl)dicyclo-hexano)-18-crown-6 ("DtBu18C6"), 1-(2,2,3,3-tetrafluoropropoxy)-3-(4-sec-butylphenoxy)-2-propanol ("Cs-7SB"), and an isoparaffinic hydrocarbon.